Tri-State Oversight Committee

Three-Year Safety and Security Review

of the Washington Metropolitan Area Transit Authority

Power Maintenance

Elements 15 and 16

Review Conducted: March, August, and October 2015

Final Report: March 22, 2016

Introduction

Representatives from the Maryland Department of Transportation (MDOT), the District of Columbia Department of Transportation (DDOT), and the Virginia Department of Rail and Public Transportation (DRPT) comprise the Tri-State Oversight Committee (TOC), which provides regular oversight of the Washington Metropolitan Area Transit Authority (WMATA) Metrorail system. To comply with State Safety Oversight Final Rule 49 Code of Federal Regulations Part 659 (Part 659), the Federal Transit Administration (FTA) requires states to designate a State Safety Oversight (SSO) agency to administer safety and security programs for rail transit and fixed guideway systems within their jurisdictions. Specifically, 49 CFR Part 659 requires TOC to conduct an on-site safety review of each element of the WMATA System Safety Program Plan (SSPP) at least once every three years. These reviews must assess WMATA's implementation with all 21 elements of its SSPP and seven elements of its Security and Emergency Preparedness Plan (SEPP), along with related plans and procedures. Beginning in 2013, the TOC has split its Three-Year Safety and Security Review topic areas into separately occurring reviews spread out during a three-year period.

The following report documents the observations and findings of the TOC's review of WMATA's power infrastructure maintenance. Generally, this review focused on whether WMATA's maintenance program complies with its own written plans as well as industry standards and best practices. These topics are the responsibility of the Power Maintenance Branch (POWR), with support and internal auditing from the Department of Safety and Environmental Management (SAFE) and Quality Assurance and Warranty (QAAW). The relevant SSPP elements for this review were all or part of:

- Element 15: Maintenance Audits/Inspections
- Element 16: Training and Certification

The TOC Program Standard and Procedures defines WMATA requirements for these elements in Section 12 and in Appendix B. Specific requirements are cited further, below.

Methodology

The TOC participated in the FTA's Safety Management Inspection (SMI) of WMATA's power maintenance in March and April 2015. TOC joined these reviews to avoid duplication of its simultaneous, ongoing Triennial Review schedule. Subsequent to the SMI, TOC conducted an abbreviated Triennial Review on August 27-28, 2015, and follow-up sessions throughout October 2015 to cover remaining questions and close the gap on topics requiring coverage between the SMI and the Triennial Review process.

In advance of the TOC follow-up review, the TOC requested and reviewed relevant WMATA plans, procedures, checklists, and reports. During the TOC and FTA on-site review sessions, the review team interviewed WMATA personnel and reviewed various documents and records to assess compliance with procedures. The reviewers also observed preventive maintenance inspections and talked with front-line personnel.

Persons interviewed (except front-line personnel) and documents reviewed are noted at the end of this report. This report identifies conditions evident during the review period, regardless of the current progress of potential remediation activities.

A Finding may refer to an instance of WMATA operating out of compliance with an applicable internal or external written requirement, plan, policy, rule, standard, or procedure. Findings may also refer to instances whereby WMATA may technically be conducting business in compliance with existing WMATA, TOC, or FTA procedures and requirements; however, there may be no relevant written plan, policy, or procedure in place, or the existing plan, policy, or procedure is not in accordance with industry best practices. Findings may be safety-critical in nature regardless of whether the issue identified is "non-compliant."

After publication of the Final Report, TOC will transfer the report to FTA for further action. FTA will then determine the appropriate mechanism by which the findings documented in this report will be addressed by WMATA.

The TOC would like to thank WMATA personnel for their time, cooperation, and forthrightness throughout the review process.

Current Conditions

Organization, Staffing, and Training

The Electrical Power Branch of the Office of Systems Maintenance (SMNT) within the Department of Transit Infrastructure and Engineering Services (TIES) is responsible for the inspection and maintenance of WMATA's power systems and equipment. Responsibility for capital improvements is now under the Office of Chief Engineer Infrastructure (CENI). General organizational responsibilities and processes are described in the Electrical Power Branch Maintenance Control Policy (MCP). That document describes performance measures, safety and hazard management programs, security, quality assurance, maintenance programs, training programs, and maintenance procedures. Specific procedures, schedules, and asset inventories for the inspection and maintenance of individual power systems and equipment are not included or identified in the policy.

The SMNT Electrical Power Branch includes a Superintendent of Power, an Assistant Superintendent responsible for inspection and maintenance, and an Assistant Superintendent who covers Maximo and safety functions. The inspection and maintenance function is organized into seven work groups, each headed by an Area Manager, for the performance of inspection, maintenance, and testing activities. Each Area Manager has several shift supervisors responsible for the direct supervision of power mechanics assigned to specific shifts and work schedules. One work group is responsible for all Measurement and Testing (M&T) and one work group is responsible for special projects. The remaining five work groups are responsible for the inspection and maintenance of low voltage (LV) and high voltage (HV) equipment. Work is assigned geographically to the five work groups located at Glenmont, Greenbelt, Rhode Island

Avenue, Shady Grove, and West Falls Church. Supervisory personnel and inspection and maintenance records are located at these area offices. The Systems Maintenance Organizational Chart dated June 1, 2015, for power identifies 36 shift supervisor positions including five vacancies.

Mechanics are classified as LV, HV, or M&T and perform work based on their classification. All mechanics assigned to a shift supervisor are of the same classification and only perform work for that classification. The organization chart indicates that the five inspection and maintenance work groups have 24 shift supervisors and 191 mechanics assigned to either LV or HV shifts. There is an AM and a PM shift for LV, and there are three shifts for HV. Seven shift supervisors and 55 mechanics are assigned to M&T, and three supervisors and 16 mechanics are assigned to LV special projects. Each shift supervisor work group has a five-day work week with distinct work hours and days off to provide coverage for all days and hours. The work schedule results in the largest number of mechanics available for work Tuesday-Thursday. Mechanics obtain shift assignments for their classification through an annual pick. New hires within each classification (M&T, HV, LV) start as mechanic helpers and may advance based on successful test completion for each level in addition to meeting the following experience requirements:

- C mechanic – one year of experience
- B mechanic - two years of experience
- A mechanic - three years of experience
- AA mechanic - four years of experience

Testing is administered by the Technical Training and Document Control (TTDC) department and includes both a written test and demonstration of practical knowledge geared to the level of advancement.

Shift supervisors assign work to mechanics based on supervisory knowledge of their qualifications. All work requires a minimum of two mechanics, only one of whom can be a helper. Mechanics can only be assigned work according to their classification as LV, HV, or M&T, but preventive maintenance procedures do not require that mechanic has attained a specific level of advancement. A 2015 breakdown of SMNT budgeted positions shows the following distribution for power mechanics:

- AA – 35%
- A – 4%
- B – 20%
- C – 20%
- Helper – 21%

The size of the helper category reflects the addition of approximately 50 new positions added to address fatigue management. The Rail Activation Plan for the Silver Line identifies 79 new positions approved for SMNT, which includes ATC and Power; however, it is not clear if the recently added positions and new hires address fatigue management or only Silver Line expansion needs.

SAFE conducts mandatory safety training. The MCP includes a Training Matrix for mechanics and supervisors indicating technical courses to be provided for each personnel category. The technical training covers inspection and maintenance procedures for specific electrical facilities and equipment and was described by WMATA as recommended rather a minimum requirement. The Training Matrix lists 25 courses and indicates 20 personnel categories to which they apply. Personnel are categorized by supervisory function (shift, area), mechanic classification (HV, LV, M&T), and mechanic level (AA, A, B, C, Helper). The number of courses identified for any one personnel category ranges from one to 20, with the largest number of courses applicable to the highest mechanic levels. Records of training completed can be queried by supervisors or TTDC for individual personnel, but there is no training matrix report or process for monitoring overall training completion and what is lacking for the entire work force. Area Managers were reported to be responsible for reviewing levels of training completion for individual personnel. Records of training completion for specific courses were provided for both the FTA and TOC reviews.

These course records indicate the following completion rates by power personnel (percentages reflect the number of personnel completing training as a percent of all power supervisory and mechanical personnel):

- GROUNDING AND BONDING – 295 completed in 2014 (97%)
- LOCK OUT TAG OUT – 280 completed in 2012-14 (92%)
- TRACTION POWER SUBSTATION – 178 completed in 2012-15 (58%)
- POWER SAFETY REFRESHER – 158 completed in 2012-14 (52%)
- BUCKET TRUCK TRAINING – 81 completed in 2012-13 (27%)
- LIFT JBL GENIE – 56 completed in 2013-14 (18%)
- AC - ROOM SWITCH GEAR TRAINING – 43 completed in 2014 (14%)
- UPS CORSARS MAINTENANCE TRAINING – 18 completed in 2013-14 (6%)
- ESCORT TRAINING – 6 completed in 2013 (2%)
- BATTERY ROOM EQUIPMENT TRAINING – 1 completed in 2003
- AC / DC FUNDAMENTALS – 1 planned in 2014
- DC SWITCHGEAR MAINTENANCE – 2 planned in 2014
- GENERATOR CONN REVIEW – 1 planned in 2014
- L / V MOTOR CONTROL & BREAKER TRAINING – 1 planned in 2014
- TRANSFORMER & RECTIFIER MAINTENANCE – 1 planned in 2014
- HOT STICK – no attendees
- INTERLOCKING POWER – no attendees

The 17 courses for which records were provided include 14 of the 25 courses listed in the Training Matrix. The majority of training completion (83%) was for the top four courses listed, each completed by 52% to 97% of mechanical and supervisory personnel. Five additional courses were completed by 6% to 27% of personnel, and the remaining eight courses had no recent completion. Courses are reported to be provided on a recurring basis over time with different courses offered each year. The refresher training courses

for safety and substation maintenance do not have a regular recurring schedule, and there is no completion requirement for refresher training. Records show that participation rates in training were generally comparable for each personnel category and classification. The reported training was completed during 2012-15 and represents about 30% of the technical training needs for all personnel based on the courses identified in the training matrix and personnel classifications. This appears to be a significant amount of training although the overall training completion record for all courses and personnel is not known.

The more comprehensive 12-week TPSS course (scheduled every Tuesday, Wednesday and Thursday for 12 weeks) is given for 10-15 mechanics at a time. There is a wait time up to two years due to demand. The MCP also identifies on-the-job Training (OJT) as an additional training source. OJT is used informally, and the Electrical Power Branch is working on a documentation process for this training.

Preventive Maintenance and Inspection

The Electrical Power Branch MCP includes a general description of the preventive maintenance (PM) process, methodology, and responsibilities including development of PM procedures, scheduling, and performance. Individual procedures and schedules for PM and equipment and systems requiring PM are not identified in the MCP. The general MCP description refers to the entry and availability of such information in Maximo. The Superintendent and Assistant Superintendent for power are responsible for implementing CENI-approved PM procedures for power equipment and systems and performing a review of all procedures every two years. The Superintendent/Assistant Superintendent are also responsible for ensuring that PM procedures are available and scheduled in Maximo prior to implementation of any new equipment. Area Managers are responsible for implementing PM performance in accordance with schedules, documenting PM completion in Maximo, and spot checking closed Maximo work orders to assure proper completion. Shift supervisors are responsible for reviewing and certifying the performance of PM inspections and the accuracy of Maximo documentation. Shift supervisors are also responsible for closing PM work orders. Mechanics are responsible for performing PM according to approved procedures and documenting completion in Maximo. The power branch has a performance completion goal of 98% for PM inspections. The SMNT General Superintendent is responsible for approving all PM procedures, which require signature by the SMNT General Superintendent (or Assistant General Superintendent for Power) and the CENI Deputy Chief Electrical Power.

Documentation provided for this review did not include a list or summary of PM procedures or schedules. The MCP indicates that this information is available through Maximo. WMATA provided a screenshot showing an Intranet Library listing and links to PM procedures. Copies of the procedures listed were also provided for the review. One discrepancy noted is a listing in the Intranet Library for Westinghouse 13kV Load Interrupter Switch FSP, whereas this equipment is identified as 15kV in the PM Procedure. A total of 58 individual PM procedures were provided for various systems and equipment. PM is required for equipment voltages of 750V DC, 480V AC, 13.8kV AC,

15kV AC, 34.5kV AC, 35kV AC, and 38kV AC. All procedures follow a similar format summarized as follows:

- Title page identifying equipment manufacturer, model, type of equipment, PM schedule, document revision number and date
- Signature approval page, signed by Power Superintendent, TIES-CENI Deputy Chief Engineer, and TSSM General Superintendent
- PM procedures are dated 2013 (49), 2012 (4), 2011 (4), and 2010 (1)
- Sections containing safety and technical references, safety warnings, and qualifications required to perform the procedure
- Sections identifying required tools and test equipment
- Sections identifying and describing the equipment, components, and function
- Sections identifying and describing required tasks for preparation, inspection, testing, and maintenance including detailed inspection and test requirements
- Data sheets required to be completed for each PM inspection or test
    - Each PM has a unique data sheet for inspection
    - Test data sheets may be unique for individual PMs
    - Many PMs use the same data sheet for megger, low voltage, and contact resistance tests

The 58 PM procedures cover a range of electrical equipment and systems with varying schedule requirements as indicated in the following summary:

- TPSS, TBS, AC Room inspection – 14 days
- Lighting/re-lamping inspections:
    - Exterior areas and parking garages – 28 days
    - Stations, tunnels, rail yards, bus garages, facilities lighting inspection – quarterly
    - Station re-lamping – annual
- Emergency generators (stationary) – monthly, annual, bi-annual
- Batteries, battery bank - 84 days, annual
- 480V AC bus tie test – 6 months
- Chiller plant AC systems - annual
- Fan shaft power systems - annual
- Third (power) rail heat tape - annual
- 750V DC circuit breaker, switchgear – annual (some 6 months)
- Thermographic inspection of equipment – 2 years
- Transformers – 2 years
- Rectifiers – 2 years, 3 years
- 480V AC circuit breaker, switchgear – 2 years, 3 years
- 13.8kV-38kV AC breaker, switchgear, load break interrupter – 2 years, 3 years
- 13.8kV ground and test device – 2 years, 3 years
- DC and AC relay calibration – 2 years, 3 years
- ETS inspection and test – 3 years
- DC track feeder cable - unscheduled

A complete list of the 58 PM procedures including document title, date, PM schedule and data sheets required is provided in the Appendix of this report.

PM work orders are generated monthly by Maximo based on the required schedules identified in the PM inspection procedures. Shift supervisors assign personnel to perform scheduled PM. Supervisors are also responsible for ensuring that completed PM documentation is entered and approved in Maximo by the 10th day of the following month as indicated in the MCP. PM completion is tracked and reported monthly in POWR PMI Compliance Summary Reports. Monthly reports from August 2014 to July 2015 were provided for the review. During this one-year period, the reports indicate that 16,280 PMs were scheduled and 16,159 were completed for an overall completion rate of 99.3%. The reports identify 38 individual PM procedures, with monthly schedules ranging from 28 to 36 for any given month. While the overall compliance rate for the year and for individual months exceeds the 98% performance goal identified in the MCP, compliance rates for several individual PMs are below the target rate, some by a significant margin. Overall PM compliance is heavily influenced by the 14-day PM procedure, which accounts for 68% of all scheduled procedures and has a 100% compliance rate. Compliance rates for 17 PMs are in the 43%-96% range with five PMs below 90% compliance. The following table lists all PM procedures, PM schedules and compliance rates as reported in the compliance summary reports:

POWR PMI Compliance Summary, 8/1/14-7/31/15	**Scheduled**	**Completed**	
14 DAY, AC SWITCHBOARD / LIGHTING INSPECTION	5298	5297	100%
14 DAY, TRACTION POWER INSPECTION	3017	3017	100%
14 DAY, TIE BREAKER INSPECTION	2751	2751	100%
14 DAY, UPS FILTER CHANGE INSPECTION	52	52	100%
28 DAYS,PARKING GARAGE LIGHTING INSPECTION	260	260	100%
STATIONARY EMERGENCY GENERATOR PM (monthly)	744	732	98%
BI- MONTHLY,SUPERVISOR ROOM INSPECTION, TPSS	329	328	100%
BI-MONTHLY,SUPERVISOR ROOM INSPECTION,TBS	336	336	100%
84 DAYS,BATTERY BANK,TPSS	492	491	100%
84 DAYS,BATTERY BANK,TBS	326	326	100%
84 DAYS,AC ROOM BATTERY INSPECTION	738	734	99%
3 MONTH,STATION LIGHTING INSPECTION	24	23	96%
3 MONTH,TUNNEL SPOT INSPECTION	290	289	100%
DRAINAGE PUMP STATION INSPECTION (quarterly)	208	205	99%
6 MONTH,AC ROOM BUSTIE TEST INSPECT	404	378	94%
6 MONTH, ANSALDO 6KA OPERATIONAL PM	42	39	93%
AC ROOM INSPECTION & RELAMP INSPECTION (6 month)	78	78	100%
9 MONTH,STATION RELAMP INSPECTION	72	71	99%
10 MONTH,STATION RELAMP INSPECTION	48	44	92%
1YEAR, FAN SHAFT INSPECTION	85	79	93%
1 YEAR,DC SWITCHGEAR INSPECTION,TPSS	110	105	95%
1 YEAR,IMPULSE DC SWITCHGEAR,TBS	1	1	100%

YEARLY,SWITCHGEAR/DC BREAKER INSPECT	100	94	94%
YEARLY,YARD ISOLATION TEST IINSPECTION,TPSS	7	3	43%
2 YEAR,TPSS H.V. SWITCHGEAR INSPECTION	16	14	88%
2 YEAR AC ROOM H.V. SWITCHGEAR INSP	38	35	92%
2 YEAR,TPSS RELAY CALIBRATION	17	15	88%
2 YEAR,AC RELAY CALIBRATION INSP	50	50	100%
2 YEAR,BI-ANNUAL BATTERY BANK INSP	91	86	95%
2 YEAR,BA-ANNUAL BATTERY BANK INSPECTION	52	52	100%
2 YEAR,BA-ANNUAL BATTERY BANK INSPECTION	30	30	100%
2 YEAR,CHILLER PLANT INSPECTION	24	22	92%
3 YEAR,TPSS H.V. SWITCHGEAR INSPECTION	11	10	91%
3 YEAR,AC ROOM H.V. SWITCHGEAR INSP	44	41	93%
3 YEAR,TPSS RELAY CALIBRATION	15	15	100%
3 YEAR,AC RELAY CALIBRATION INSP	8	8	100%
3 YEAR,ETS TEST AND INSPECTION	26	18	69%
3 YEAR , HAND HOLE INSPECTION	46	30	65%
	16280	**16159**	**99.3%**

PM procedures above are listed in order of frequency performed. PM compliance may vary for individual months as compared to the yearly average shown. Although the total number of PMs not completed is relatively small, there is a significant percentage of incomplete inspections for a few of the procedures, most notably:

- YEARLY,YARD ISOLATION TEST IINSPECTION,TPSS – 43% compliance
- 3 YEAR,ETS TEST AND INSPECTION – 69% compliance
- 3 YEAR , HAND HOLE INSPECTION – 65% compliance

Although 58 individual documented PM procedures were provided and only 38 PM procedures are included in the compliance report, part of the difference is a result of there being several two-year and three-year PM procedures for individual makes and models of equipment which can be scheduled in Maximo as the same PM type. However, there are some discrepancies between the PM information in Maximo and the PM procedure documents provided:

- The compliance report lists a 2 Year Battery bank PM but the PM document provided requires a 364-day inspection in addition to the 84-day inspection.
- The compliance report lists a 2 Year Chiller PM but the PM document provided requires a 364-day inspection.
- No PM procedure document was provided for the following PMs listed in the compliance report:
    - BI-MONTHLY,SUPERVISOR ROOM INSPECTION, TPSS
    - BI-MONTHLY,SUPERVISOR ROOM INSPECTION,TBS
    - DRAINAGE PUMP STATION INSPECTION (quarterly)
    - YEARLY,YARD ISOLATION TEST IINSPECTION,TPSS
    - 3 YEAR , HAND HOLE INSPECTION

- The compliance report does not include PM for the following PM procedure documents provided:
    - Oil-Filled Transformer Class OA, OA/FA – 728 Day Inspection
    - DRY-TYPE TRANSFORMER, CLASS AA/FA – 728 DAY INSPECTION
    - HV INSTRUMENT TRANSFORMERS AUXILIARY METERING COMPARTMENTS – 728 DAY INSPECTION
    - TRACTION RECTIFIER – 728/1090 DAY INSPECTION
    - THIRD RAIL HEAT TAPE SYSTEM - 365 DAY INSPECTION
    - THERMOGRAPHIC INSPECTION OF ELECTRICAL EQUIPMENT - 728 DAY INSPECTION
    - TRACK FEEDER CABLE 1000 KCMIL
    - POWELL 13.8 kV AC TYPE PV-E ELECTRICALLY OPERATED GROUND & TEST DEVICE – 728/1090 DAY INSPECTION

During the reviews, it was reported that thermographic testing is conducted quarterly by train-mounted equipment for wayside electrical components. This differs from the 728-day PM Thermographic Inspection of Electrical Equipment which was reported to be performed as needed during other PM of TPSS equipment. The Track Feeder Cable PM is no longer scheduled since testing determined that all cable needed to be replaced 15 years ago. A multi-year State of Good Repair project for cable replacement was initiated but has not been completed.

All PM procedures require completion of one or more data sheets. The data sheets associated with each PM are identified in the list of Power Preventive Maintenance Inspection Procedures in the Appendix of this report. Data sheets identify the procedure being performed and the tasks to be completed, indexed by the task number in the PM procedure document. Space is provided to indicate PM location, date, completion of tasks, entry of values, mechanic identity, and supervisor signature. Completed data sheets are required to be on file at the Electrical Power Branch Area Office where shift supervisors responsible for PM completion are located. PM procedures are to be available to supervisors and mechanics at the Area Office by hard copy or online.

The Maintenance Planning (MPLN) group is responsible for entering inspections into Maximo for all maintenance groups except Car Maintenance, (CMNT), Elevator/Escalator (ELES), Plant Maintenance (PLNT) and Bus Maintenance (BMNT). Once an inspection is entered, it remains at the assigned frequency until someone removes it. There is not a separate asset list document, but rather Maximo acts as the asset list. When a maintenance division receives new equipment, someone from that office must call or e-mail MPLN to request the asset be added to Maximo at the frequency required by the vendor or WMATA engineers; there is not a specific point person for each department, and there is no documentation to confirm the appropriate frequency is submitted to MPLN. MPLN is reportedly composing a business process to formalize its practices.

Corrective Maintenance

A Corrective Maintenance (CM) work order is opened when a repair or adjustment is required as a result of PM inspection or an incident report. The Rail Operations Control Center (ROCC) issues an Incident work order if service is impacted. The Maintenance

Operations Center (within the ROCC) then issues a corresponding CM work order. The MCP provides a brief description of the Maximo work order process. Area Managers and Shift Supervisors are responsible for monitoring CM completion. WMATA provided a Maximo work order report as of August 17, 2015, listing all open work orders for Power. The report includes 1,819 open work orders from October 20, 2006, to August 17, 2015. The report shows the reported date the work order was created and does not include work orders that have been closed. The following is a summary of open CM work orders by year reported:

- Year Reported
    - 2015 – 1,330 (73%)
    - 2014 – 361 (20%)
    - 2013 – 37 (2%)
    - 2012 – 55 (3%)
    - 2011 – 19 (1%)
    - 2010 – 6 (<1%)
    - 2009 – 7
    - 2008 – 1
    - 2007 – 2
    - 2006 – 1
- Three-month averages
    - 250 from June to August, 2015
    - 142 from March to May, 2015
    - 65 from December to February, 2015
    - 47 from September to November, 2014
    - 28 from June to August, 2014
    - 18 from March to May, 2014
    - 16 from December to February, 2014
    - 5 from September to November, 2013
    - 3 from June to August, 2013
    - 2 from March to May, 2013

The distribution by year indicate that the vast majority of work orders are for the current year with steadily decreasing numbers going back to earlier years as earlier work is completed. The three-month average also shows a steady decline of work orders remaining open. The report does not classify the work orders by priority so it is not possible to assess the criticality of work orders that remain open.

QAAW

There were 35 QAAW audit reports of power maintenance performed in 2012-14 based on reports provided for the review. The number of audits steadily increased from 8 in 2012 to 11 in 2013 and 16 in 2014. The breakdown of functions audited is as follows:

- Calibration – 7 audits, 27 discrepancies
- Power PMI – 21 audits, 15 discrepancies (11 audits had no discrepancies)
- ETS follow-up – 3 audits, 20 discrepancies

- RWP – 4 audits, 3 discrepancies (1 audit had no discrepancies)

Calibration audits had the highest rate of discrepancies, possibly due to the number of tools checked. There was less than one discrepancy per PM inspection audit, on average, and half had no discrepancies. The focus of the PM audits was to verify that proper safety and PM procedures were followed when performing a specific PM procedure. The ETS follow-up is a special review performed once each in 2012 and 2014.

PM Records

The TOC conducted a review of data sheet records at the West Falls Church and Greenbelt Area Offices. Inspection data sheets selected for review included AC and DC TPSS Inspections, all tunnel and station lighting inspections/relampings, and ETS testing, for various periods between 2013 and July 2015. Files for PM procedures were selected and reviewed to assess the quality of records. While reviewing files for the 14-day PM for C13, K07, and J03, it was discovered that no records were filed for 2015 beyond April and in 2014 between August and November. Dates on the available data sheets indicated compliance with the 14-day PM schedule.

There were no completed station lighting inspection data sheets at either field office, except for a few errant copies from 2010. It was unclear how this corresponds with WMATA's Maximo reports stating that both field offices completed 100% of 9-month/10-month station lighting/relamp inspections from January 2014 through September 2015. Similarly, ETS testing data sheets were missing from all years except 2011 and 2014. Maximo records provided to TOC show that these two field offices scheduled and completed some ETS inspections in 2013 and 2015.

In addition, the availability, location, and use of PM procedure documents by supervisory and technical personnel was not clear and could not be confirmed. Personnel at one location visited were unaware of the existence certain PM procedures, which TOC copied and provided to them.

There were additional problems with the records, as noted in the Findings section below.

FTA Findings

In addition to the new issues identified in the Findings section below, the TOC concurs with the following findings and recommendations from the FTA's SMI report dated June 17, 2015:

Finding R-15 Maintenance and Operations Departments have not ensured the RWP training program is being conducted as required. Annual refresher and biennial re-certification requirements for Level II and Level IV are behind schedule.	R-2-15-a Each WMATA Department with Roadway Worker Protection-trained and qualified employees must coordinate with Technical Skills & Maintenance Training to get or establish an accurate status on each employee's refresher and requalification training.
	R-2-15-b Each WMATA employee with lapsed refresher training or requalification must repeat the initial training and qualification for his or her level as specified in WMATA's roadway worker protection training program.

	R-2-15-c WMATA's Information Technology Department must work with Technical Skills & Maintenance Training to develop a long-term solution to tracking employee status and ensuring that Computer-Based Training records, classroom records and employee records are accessible to all departments.
	R-2-15-d WMATA must include annual Roadway Worker Protection refresher and requalification time in overall work scheduling protocols and requirements.
Finding R-16 Technical Training for operations and maintenance departments is underresourced and fractured, currently provided by five different departments and IT, is insufficiently directed and resourced, and relies significantly on on-the-job-training (OJT) which is informal and lacks oversight.	R-2-16-a WMATA must conduct a coordinated study to prioritize technical training needs for maintenance personnel, and operations training for Rail Traffic Controller, Train Operators, and Field Supervisors.
	R-2-16-b WMATA must evaluate whether re-organization or consolidation of training functions would improve the agency's ability to manage, schedule, budget for, develop, oversee and assess training and ensure that training material remains up-to-date.
	R-2-16-c WMATA must establish a comprehensive training program to communicate the new "Fire Life Safety 1000 --Inspection, Testing and Maintenance Procedure" to WMATA Operations and Maintenance personnel.
	R-2-16-d WMATA must establish formal guidance for maintenance employees responsible for providing on-the-job training.

Finding R-23 Current OWL nighttime maintenance window typically only allows between 90 minutes and two hours of on track time.	R-3-23-a WMATA must ensure that a process is in place for identifying and scheduling sufficient track time to complete required inspection, testing and maintenance activities.
Finding R-24 WMATA has reduced other options for track access, including holiday weekend work shut-downs, early outs, and single-tracking.	R-3-24-a WMATA must establish firm limits on minimum track time for inspection, testing and maintenance activities per month, and revisit limits annually.
Finding R-25 Due to lack of track time, WMATA's maintenance departments must consistently re-schedule work, and, as a result, have growing maintenance backlogs, dating back to 2012 and 2013	R-3-25-a WMATA must develop and implement staffing plans to eliminate maintenance work orders backlogs and manage on-going workload in track and structures, traction power, communications, and automated train control departments.
Finding R-26 Efficiencies can be obtained to improve the way in which WMATA's workers and contractors currently access the right-of-way.	R-3-26-a WMATA must improve interdepartmental coordination and communication to take full advantage of track time.

Finding R-27 Documented maintenance procedures and standard operating procedures are not implemented as required.	R-4-27-a For all major departments with inspection and maintenance responsibilities for critical infrastructure, WMATA must establish and/or update a preventive maintenance and inspection testing quality audit process to ensure compliance with established maintenance and testing practices, and to monitor missed or incomplete preventive maintenance activities and/or inspections.
Finding R-30 WMATA's program for measuring, documenting and addressing the potential impacts of stray negative return current on the condition of WMATA's infrastructure is not documented in a formal plan to ensure coordination across departments and contractor services.	R-4-30-a WMATA must develop a plan to document roles and responsibilities, activities, and points of coordination regarding its program to measure, document and mitigate the impacts of stray negative return current.
Finding R-32 WMATA has no formal program for reviewing the proficiency of maintenance field staff.	R-4-32-a WMATA must ensure that each department within Transit Infrastructure and Engineering Services creates a formal program of Supervisory inspections to observe maintenance, look at quality of work in the field, and formally intervene to evaluate, re-train (if necessary), and enhance the professional development of employees.
Finding R-33 Inventory "stockouts" have impacted maintenance operations. Material control stock out items are reported by Superintendents in Rail Car Maintenance, Traction Power and Plant as a serious concern in the performance of maintenance activities and ensuring equipment	R-4-33-a Each WMATA Department impacted by inventory stockouts must develop a recovery or corrective action plan to ensure equipment availability and to manage delays.

availability, however mitigations have not been implemented.	

Finding R-34 Priority maintenance work for Fire/Life Safety (FLS) systems and other critical infrastructure with shared departmental responsibilities for inspection and maintenance is not completed as required.	R-5-34-a WMATA must complete its "Fire/Life Safety 1000" maintenance procedure, to clarify roles and responsibilities, and outline expectations regarding how departments should work together to coordinate inspection, maintenance and repair of these system components.
Finding R-35 WMATA must do more to prevent and manage conditions that cause smoke in tunnels.	R-5-35-a WMATA must establish clear definitions for infrastructure conditions requiring immediate or emergency action, such as "arcing insulator."
	R-5-35-b WMATA must address third rail insulator cleaning and replacement requirements and third rail jumper cable inspection and replacement requirements as part of the "FLS 1000" procedure, or in separate but referenced procedures.
	R-5-35-d WMATA must resume its program for cable insulation resistance testing for its power cables. Insulation resistance testing should be performed on power cables every 10 years.
	R-5-35-e WMATA must replace all defective power cables that have been identified by traction power inspectors and maintainers.

The TOC does not require a separate response to the FTA findings. The TOC will monitor implementation of the recommendations through WMATA's CAP submissions to the FTA.

TOC Findings

Finding 1: PM compliance falls below the 98% goal established in the Electrical Power Branch Maintenance Control Policy for 17 categories of PM. Compliance rates for these inspections range between 43% and 96%, based on scheduled PM for every 12 months. Several PM categories meet the 98% goal for some but not all months. A few PM categories are significantly below the established goal. Further details are in a table in the Preventive Maintenance and Inspection subsection of this report, above.

Finding 2: Data sheets were missing for numerous inspections that are claimed to be complete in Maximo. There were no completed station lighting inspection data sheets at either the West Falls Church or Greenbelt field office, except for a few errant copies from 2010. It was unclear how this corresponds with WMATA's Maximo reports stating that both field offices completed 100% of 9-month/10-month station lighting/relamp inspections from January 2014 through September 2015. Similarly, ETS testing data sheets were missing from all years except 2011 and 2014. Maximo records provided to TOC show that these two field offices scheduled and completed some ETS inspections in 2013 and 2015.

Finding 3: There are schedule discrepancies between some PMI documents and PM completion schedules. The Maximo PM descriptions in monthly PMI Compliance Summary Reports indicate a two-year cycle for battery bank (bi-annual) and chiller plant inspection but the PMI procedure documents indicate an annual schedule.

Finding 4: PMI Compliance Summary Reports do not include information on several PMs that have an inspection schedule identified in PMI documents. PMI documents provided for the review indicate a 728-day schedule for transformer PM, a 728/1,090-day schedule for rectifier PM, a 365-day schedule for 3rd Rail Heat Tape PM, a 728-day schedule for Thermographic PM and a 728/1,090-day schedule for Powell 13.8kV Ground & Test Device PM. Scheduling and completion of these PMs do not appear to be included in the monthly compliance reports.

Finding 5: PM procedure documentation was not provided for some PM identified in monthly PMI Compliance Summary Reports. Monthly compliance reports identify PM completion for which PMI Procedure documents were not provided, including Bi-monthly Supervisor Room Inspection (TPSS/TBS), Drainage Pump Station Inspection, Yearly Yard Isolation Test Inspection (TPSS), and 3 Year Hand Hole Inspection.

Finding 6: Multiple versions of the same inspection form are being used for AC and DC breaker inspections; the steps in each are not consistent. At the Greenbelt office, the 2004 version of the AC TPSS data sheet was used for inspections of G04-AC2 in 2014. However, the most recent version that should be used is from 2011. This form, though, is missing steps compared to the 2004 version. The same problem for these inspections were identified at the West Falls Church office as well.

Finding 7: Field office personnel were not aware of the existence of some PM procedure documents. TOC copied and provided a PM procedure to a manager at one location. It is important for all personnel to be trained on and have access to vital procedures in their area of work.

Finding 8: Neither data sheets nor maintenance procedures define acceptable thresholds for some measurements. For example, the AC TPSS Inspection data sheet requires the recording of information such as voltage leakage, but neither the data sheet nor the PMI lists the proper threshold. It is important for proper thresholds to be clearly marked so that action may be taken for measurements that fall outside the acceptable limits.

Finding 9: There is no requirement to note corrective maintenance work order numbers alongside defects identified during inspections. As a result, managers cannot identify whether defects have been addressed. TOC noted some defects repeated in consecutive inspections, which shows that the defects were not addressed. For example, the same three fans are shown as inoperable every month between January and May 2014 for C05-AC1. There are remarks on many forms that state, for example, “Photo cell switch needs replacing” or “Circuit problem on both tracks that needs troubleshooting,” but there is no connection to the resolution/corrective maintenance.

Finding 10: There is no process for monitoring the completion of technical training by power mechanics. A training matrix for mechanics and supervisors defines a program comprised of 25 technical training courses and 20 personnel classifications. It is not

evident in any documentation whether completion of the training program is a requirement or recommendation, or if there is a specific timeframe for completion. There does not appear to be a process for tracking the progress of individual personnel in completing the courses identified for their classification. Completion information provided indicates who has taken a course, but WMATA does not track which remaining personnel may need a course.

Finding 11: MPLN does not yet have written practices or procedures to define the communication needed between its coordinators and other departments. MPLN is responsible for the entry of important preventive maintenance inspection frequencies into Maximo. It varies by department whether there is a point person to convey information to MPLN on new assets requiring maintenance. There is also no verifying documentation or engineering approval sent to MPLN to confirm the proper maintenance frequency that should be set in Maximo. MPLN reported that the creation of written business practices was already underway; these documents should specify the interdepartmental coordination that must take place and be sent to the relevant departments for proper implementation.

Persons Interviewed

- [redacted] (POWR)
- [redacted] (POWR)
- [redacted] (POWR)
- [redacted] (TASS)
- [redacted] (POWR)
- [redacted] (POWR)
- [redacted] (POWR)
- [redacted] (POWR)
- [redacted] (POWR)
- [redacted] (TTDC)
- [redacted] (TTDC)
- [redacted] (MPLN)
- Frontline employees – names withheld

Documents Received / Reviewed

- WMATA 2014 SSPP Signed, January 2014
- WMATA 2015 SSPP Signed, January 2015
- Various OEM manuals and WMATA training materials for new assets
- Power Training Matrix (required training table)
- Course attendance spreadsheets for safety training
- Aerial Bucket Truck Operation Requirements
- Electrical Concepts (IEEE Standards, Symbols, Wiring Diagrams)
- Interlocking Operator's Training – outline and photos
- Introduction to Circuit Breaker Maintenance Operations Test Course
- Student Study Guide: AC Room Equipment

- Sample “Team Members Training Record” (3)
- Records of enrollment for 17 completed courses, 2013-2015
- TTDC SOP 1: TTDC Business Processes, 4/8/15
- TTDC SOP 3: Class Cancellation Processes, 5/26/15
- Systems Maintenance Organizational Chart, 6/1/15
- Power Open CM Work Orders (Spreadsheet), 8/17/15
- Power Compliance Report Summary: 2013-2015 ETS testing and 2014-2015 station relamping for West Falls Church and Greenbelt field office districts
- Power Compliance Report Summary: 2- and 3-year PMs, May 2014-May 2015
- Reliability Engineering & Performance Analysis POWR Incident & Performance Report, 2015 to date
- Monthly POWR PMI Compliance Summary Reports, August 2014 – July 2015
- Electrical Power Branch Maintenance Control Policy, 10/5/12
- PM work order list, open and closed, for POWR E99
- QAAW audit reports of POWR (15 files)
- CM Work Order list Opened 1/1/15-1/31/15
- CM Work Order list Closed 1/1/15-1/31/15
- CM Word Order list Closed POWR HVE99 1/1/14-2/24/15
- Labor compliance summary reports: 1/25/15-1/31/15; 2/1/15-2/7/15; 2/8/15-2/14/15
- Work Order Details: TPSS Test Procedures
- SMNT Budgeted Position Breakdown 2-26-15
- SMNT Staffing Breakdown 2-25-15
- Closed PM Work Order list for POWR 11/3/13-10/19/14
- Open PM Work Order list for POWR 3/14/14-10/23/14
- Data Sheets from Greenbelt and West Falls Church field office districts, including AC TPSS Room Inspections, Station Lighting/Relamp, Tunnel Lights, and ETS Testing
- Various Preventive Maintenance Inspection Procedures (See Appendix)

Appendix: Power Preventive Maintenance Inspection Procedures

Traction Power Facilities, Systems and Equipment:

- AC OR DC ELECTRICAL FACILITIES - 14 Day Inspection, Rev 3, 8/5/11
  - AC UNIT SUBSTATIONS
  - AUXILIARY ELECTRICAL ROOMS
  - TRACTION POWER SUBSTATIONS
  - DC TIE BREAKER SUBSTATIONS
  - Data Sheet - DC Traction Power and Tie Breaker Facility Inspection (2 versions)
- BATTERY MAINTENANCE - 84 Day Inspection, 364 Day Inspection, Rev 1, 8/22/11
  - Battery Data Sheet 1 and 2
  - Battery Torque Data Sheet
- Oil-Filled Transformer Class OA, OA/FA – 728 Day Inspection, Rev 2, 6/21/13
  - Data Sheet – untitled, included in procedure
- DRY-TYPE TRANSFORMER, CLASS AA/FA – 728 DAY INSPECTION, Rev 3, 6/21/13
  - Data Sheet - POWER PREVENTIVE MAINTENANCE INSPECTION CHECK LIST DRY TYPE TRANSFORMER, CLASS AA/FA
- HV INSTRUMENT TRANSFORMERS (POTENTIAL TRANSFORMERS), AUXILIARY METERING COMPARTMENTS – 728 DAY INSPECTION, Rev 2, 9/13/12
  - Data Sheet - PREVENTIVE MAINTENANCE INSPECTION CHECK LIST MV INSTRUMENT (POTENTIAL) TRANSFORMERS, AUXILIARY METERING COMPARTMENTS
- TRACTION RECTIFIER – 728/1090 DAY INSPECTION, Rev 2, 9/5/12
  - Data Sheet - RECTIFIER MAINTENANCE AND TEST RECORD
- THIRD RAIL HEAT TAPE SYSTEM - 365 DAY INSPECTION, Rev 3, 6/20/13
  - Data Sheet - POWER PREVENTIVE MAINTENANCE INSPECTION CHECK LIST HEAT TAPE SYSTEM INSPECTION
  - Log Sheets - by track section
- THERMOGRAPHIC INSPECTION OF ELECTRICAL EQUIPMENT - 728 DAY INSPECTION, Rev 1, 6/17/13
  - Data Sheet - PREVENTIVE MAINTENANCE INSPECTION CHECK LIST THERMOGRAPHIC INSPECTION OF ELECTRICAL EQUIPMENT
  - INFRARED TEST DATA SHEET
- EMERGENCY TRIP STATION (ETS) – 1092 DAY INSPECTION, Rev 3, 6/20/13
  - Data Sheet - ETS INSPECTION AND TRIP VERIFICATION TEST PLAN
  - ETS INSPECTION AND TRIP VERIFICATION TEST LOG - by ETS Box #
- TRACK FEEDER CABLE 1000 KCMIL, Rev 3, 8/19/11 (no inspection interval specified)
  - POWER CABLE MEGGERING DATA SHEET

750V DC Equipment:

- 750 VOLT DC WESTINGHOUSE SWITCHGEAR – 184 DAY, Rev 3, 6/1/13
    - 750V DC (WESTINGHOUSE) SWITCHGEAR DATA SHEET
- ANSALDO 750V DC BREAKER & SWITCHGEAR - 270 DAY INSPECTION Rev 3, 8/19/11
    - 750 V DC ANSALDO SWITCHGEAR DATA SHEET
- ABB 750 Volt DC Type FBK-S Circuit Breaker - 365 Day Inspection, Rev 3, 6/21/13
    - Data Sheet - ABB TYPE FBK-S (SEMI-HIGH-SPEED) 750 VDC CIRCUIT BREAKER
- ABB/BBC/ITE 750 Volt DC Type FBK-H Circuit Breaker - 365 Day Inspection, Rev 3, 6/21/13
    - Data Sheet - ABB TYPE FBK-H (HIGH-SPEED) 750 VDC CIRCUIT BREAKER
- GEC EEC CPC 750 VOLT DC SWITCHGEAR - Annual Inspection, Rev 3, 6/20/13
    - 750V DC GEC, EEC AND CPC DATA SHEET
- WHIPP & BOURNE 750 VOLT DC TYPE MM74 CIRCUIT BREAKER - 365 DAY INSPECTION, Rev 3, 6/20/13
    - Data Sheet - WHIPP & BOURNE MM74 750 VDC CIRCUIT BREAKER
- G.E. 750 V DC MC6 BREAKER - Annual Inspection, Rev 2, 3/20/12
    - 750V DC (G.E.) BREAKER DATA SHEET
- 750V DC BREAKER RECLOSER RELAY TYPE 82/83 – 728/1090 DAY INSPECTION, Rev 2, 6/21/13
    - RECLOSER RELAY PMI INSPECTION & TEST RECORD – data sheet 1
    - RECLOSER RELAY PMI INSPECTION & TEST RECORD – data sheet 2
- 750V DC SWITCHGEAR OVERCURRENT RELAY (SOLID STATE TYPE 76) – 728/1090 DAY INSPECTION, Rev 1, 6/17/13
    - DC OVERCURRENT RELAY (SOLID STATE TYPE 76) PMI DATA SHEET
    - Data Sheet - 76 DC OVERCURRENT RELAY PMI INSPECTION AND TEST RECORD
- 750V DC HIGH RESISTANCE ENERGIZED/GROUNDED STRUCTURE (64) RELAY – 728/1090 DAY INSPECTION, Rev 1, 9/20/12
    - Data Sheet - HIGH RESISTANCE - ENERGIZED/GROUNDED STRUCTURE RELAY PMI CHECK LIST
    - Data Sheet - HIGH RESISTANCE ENERGIZED/GROUNDED STRUCTURE RELAY PMI INSPECTION & TEST RECORD

480V AC Equipment:

- FEDERAL PIONEER 480V AC TYPE H-2/HL-2 A ND H-3/ HL-3 AIR CIRCUIT BREAKERS AND SWITCHGEAR - 728/1090 DAY INSPECTION, Rev 3, 6/21/13
    - Traction Power, Plant Facilities and AC Rooms

    - Data Sheet - INSPECTION AND OPERATIONAL TEST FEDERAL PIONEER TYPE H-2/HL-2 AND H-3/HL3 480V AC LOW VOLTAGE POWER CIRCUIT BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
    - Data Sheet - LOW VOLTAGE BREAKER TEST RECORD
- FEDERAL PACIFIC ELECTRIC 480V AC TYPES FP/FM-25, -50, -75 CIRCUIT BREAKER AND SWITCHGEAR - 728/1090 DAY INSPECTION, Rev 3, 6/21/13
    - Bus, Rail, Storeroom and Plant Facilities
    - Data Sheet - INSPECTION AND OPERATIONAL TEST 480V AC, FEDERAL PACIFIC TYPE FP/FM LOW VOLTAGE POWER CIRCUIT BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
    - Data Sheet - LOW VOLTAGE BREAKER TEST RECORD
- SIEMENS RL 480V AC BREAKER AND SWITCHGEAR - 728/1090 DAY INSPECTION, Rev 3, 6/21/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST 480V AC, SIEMENS TYPE RL LOW VOLTAGE POWER CIRCUIT BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
    - Data Sheet - LOW VOLTAGE BREAKER TEST RECORD
- WESTINGHOUSE ELECTRIC TYPE DS 480V AC CIRCUIT BREAKERS AND SWITCHGEAR – 728/1090 DAY INSPECTION, Rev 3, 10/7/10
    - Bus, Rail, Storeroom and Plant Facilities
    - Data Sheet - INSPECTION AND OPERATIONAL TEST 480V AC, WESTINGHOUSE TYPE DS LOW VOLTAGE POWER CIRCUIT BREAKER AND SWITCHGEAR
    - Data Sheet - LOW VOLTAGE POWER CIRCUIT BREAKER INSULATION RESISTANCE (MEGGER) and CONTACT RESISTANCE TESTS
    - Data Sheet - LOW VOLTAGE POWER CIRCUIT BREAKER TRIP UNIT TEST RESULTS
- GENERAL ELECTRIC 480V AC TYPE AK, AKR AND AKRT CIRCUIT BREAKERS AND SWITCHGEAR – 728/1090 DAY INSPECTION, Rev 2, 6/20/13
    - Bus, Rail, Storeroom and Plant Facilities
    - Data Sheet - INSPECTION AND OPERATIONAL TEST 480V AC, TYPE AK, AKR LOW VOLTAGE POWER CIRCUIT BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
    - Data Sheet - LOW VOLTAGE BREAKER TEST RECORD
- ITE – GOULD 480VAC POWER CIRCUIT BREAKERS TYPES K-225 THROUGH K-2000 AND TYPES K-600S THROUGH K-2000S – 728/1090 DAY INSPECTION, Rev 2 6/20/13
    - Bus, Rail, Storeroom and Plant Facilities

    - 750V DC GEC, EEC AND CPC DATA SHEET
- AUTOMATIC BUS TIE 480 VOLT AC SWITCHGEAR OPERATIONAL TEST – SEMI-ANNUAL, Rev 2, 6/20/13
    - Data Sheet - AUTOMATIC VOLT BUS TIE TEST RECORD

13.8kV-38kV AC Equipment:

- SIEMENS-ALLIS 13.8 kV AC TYPE FC-500B AIR-MAGNETIC BREAKER AND SWITCHGEAR – 728 DAY INSPECTION, Rev 2, 6/20/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST SIEMENS-ALLIS 13.8 kV AC, TYPE FC-500B AIR-MAGNETIC BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- FEDERAL PACIFIC ELECTRIC 13.8 kV AC TYPE DST-2 AIR MAGNETIC BREAKER AND SWITCHGEAR – 728/1090 DAYINSPECTION, Rev 2, 6/21/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST 13.8 kV AC, FPE TYPE DST-W AIR MAGNETIC BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- 13.8 kV AC WESTINGHOUSE TYPE DHP AIR MAGNETIC BREAKER AND SWITCHGEAR – 728/1090 DAY INSPECTION, Rev 2, 6/21/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST WESTINGHOUSE 13.8 kV AC, TYPE DHP AIR MAGNETIC BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- 13.8 kV AC WESTINGHOUSE TYPE VCP-W VACUUM BREAKER AND SWITCHGEAR – 728/1090 DAY INSPECTION, Rev 2, 6/20/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST WESTINGHOUSE 13.8 kV AC, TYPE VCP-W VACUUM BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- ABB 13.8 kV AC TYPE 15VHK VACUUM BREAKER AND SWITCHGEAR – 728/1090 DAY INSPECTION, Rev 2, 6/20/13
    - Data Sheet -INSPECTION AND OPERATIONAL TEST ABB 13.8 kV AC, TYPE 15VHK VACUUM BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- GE 13.8 kV AC MAGNA-BLAST CIRCUIT BREAKER – 728/1090 DAY INSPECTION, Rev 2, 6/20/13
    - Data Sheet - PMI CHECKLIST - AIR CIRCUIT BREAKER (G.E. MAGNA-BLAST)
- ITE/BBC/ABB 13.8 kV AC TYPE 15HK AIR MAGNETIC BREAKER AND SWITCHGEAR – 728/1090 DAY INSPECTION, Rev 2, 6/20/13

    - B05 (Brookland-CUA) and E03 (U Street) AC Rooms
    - Data Sheet - INSPECTION AND OPERATIONAL TEST ABB 13.8Kv ac, type 15vhk VACUUM BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- POWELL SERIES 13.8 kV AC TYPE P60000 VACUUM CIRCUIT BREAKER AND SERIES P-51000 METAL-CLAD SWITCHGEAR – 728/1090 DAY INSPECTION, Rev 2, 6/20/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST POWELL 13.8 kV AC, SERIES P-60000 POWL-VAC VACUUM BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- SIEMENS 13.8 kV AC TYPE GMI VACUUM BREAKER AND SWITCHGEAR – 728/1090 DAY INSPECTION, Rev 2, 6/20/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST 13.8 kV AC, SIEMENS TYPE GMI VACUUM BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- SQUARE D 13.8 kV AC TYPE VAD - 3 VACUUM BREAKER AND SWITCHGEAR – 728/1090 DAY INSPECTION, Rev 2, 6/20/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST – PMI DATA SHEET 13.8 kV AC, SQUARE D TYPE VAD - 3 VACUUM BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- TOSHIBA 13.8 kV AC TYPE VK 10M40 VACUUM BREAKER AND SWITCHGEAR – 1090 DAY INSPECTION, Rev 2, 6/20/13
    - Data Sheet -INSPECTION AND OPERATIONAL TEST 13.8 kV AC, TOSHIBA TYPE VK 10M40 VACUUM BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- ABB/BBC/ITE 13.8 kV AC TYPE HPL-C LOAD BREAK INTERRUPTER SWITCHES - 728/1090 DAY INSPECTION Rev 2, 6/21/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST - ABB/BBC/ITE TYPE HPL-C AC HIGH VOLTAGE METAL-ENCLOSED LOAD INTERRUPTER SWITCH
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and FUSE OR CONTACT RESISTANCE TESTS
- FEDERAL PACIFIC ELECTRIC 13.8 kV AC TYPE LI LOAD BREAK INTERRUPTER SWITCHES – 728/1090 DAY INSPECTION, Rev 2, 6/21/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST - FEDERAL PACIFIC ELECTRIC TYPE LI AC HIGH VOLTAGE METAL-ENCLOSED LOAD INTERRUPTER SWITCH

    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and FUSE OR CONTACT RESISTANCE TESTS
- GE LOAD INTERRUPTER SWITCH 13.8KV AC TYPE SE-100S – 728/1090 DAY INSPECTION, Rev 2, 6/21/13
    - Data Sheet - GE TYPE SE-100S 13.8KV LOAD INTERRUPTER SWITCHES
    - Data Sheet - LOAD INTERRUPTER SWITCH FUSE AND CONTACT RESISTANCE TEST
- 13.8kV WESTINGHOUSE LOAD BREAK INTERRUPTER SWITCH TYPE AWP – 728/1090 DAY INSPECTION, Rev 2 6/21/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST - WESTINGHOUSE TYPE AWP AC HIGH VOLTAGE METAL-ENCLOSED LOAD INTERRUPTER SWITCH
    - Data Sheet - LOAD INTERRUPTER SWITCH FUSE AND CONTACT RESISTANCE TEST
- POWELL 13.8 kV AC TYPE PV-E ELECTRICALLY OPERATED GROUND & TEST DEVICE – 728/1090 DAY INSPECTION, Rev 2, 6/20/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST POWELL TYPE ELECTRICALLY OPERATED GROUND AND TEST DEVICE
    - Data Sheet - POWELL GROUND AND TEST DEVICE HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- 15 kV AC WESTINGHOUSE DRAW-OUT TYPE FSP LOAD INTERRUPTER SWITCH – 728/1090 DAY INSPECTION, Rev 10, 6/21/13
    - Shady Grove S&I Shop
    - Data Sheet - LOAD INTERRUPTER SWITCH FUSE AND CONTACT RESISTANCE TEST RECORD
    - Data Sheet - MEGGER (INSULATION RESISTANCE) AND HI-POT (DIELECTRIC WITHSTAND) TEST RECORD
    - Data Sheet - WESTINGHOUSE TYPE FSP 15KV DRAW-OUT FUSED INTERRUPTER SWITCHES LOCATED AT: SHADY GROVE S&I SHOP, DC SHOP POWER SUBSTATION A100-DC, INCOMING LINE SWITCHES #1 and #2
- 34.5 & 13.8 kV AC POWERCON TYPE PIF LOAD BREAK INTERRUPTER SWITCHES – 728/1090 DAY INSPECTION, Rev 2, 6/20/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST - POWERCON TYPE PIF AC HIGH VOLTAGE METAL-ENCLOSED LOAD INTERRUPTER SWITCH
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- OVERCURRENT RELAYS 34.5 & 13.8 kV AC SYSTEMS – 728/1090 DAY INSPECTION, Rev 2, 6/21/13
    - OVERCURRENT RELAY PMI DATA SHEET
    - OVERCURRENT RELAY PMI INSPECTION & TEST RECORD
- 34.5 & 13.8 kV AC UNDER/OVERVOLTAGE RELAYS – 728/1090 DAY INSPECTION, Rev 3, 6/21/13

    - UNDER/OVERVOLTAGE RELAY PMI DATA SHEET
    - UNDER/OVERVOLTAGE RELAY PMI INSPECTION & TEST RECORD
- GENERAL ELECTRIC 34.5 kV AC TYPE VH-34.5-1500, MODEL: - 2L VACUUM BREAKER AND SWITCHGEAR – 728/1090 DAY INSPECTION, Rev 2, 6/20/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST GENERAL ELECTRIC 34.5 kV AC, TYPE VH-34.5-1500, MODEL: - 2L VACUUM BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- GENERAL ELECTRIC 34.5 kV AC TYPE VH-34.5-1500, MODELS:- 0K, -1K, & -0L VACUUM BREAKER AND SWITCHGEAR – 728/1090 DAY INSPECTION, Rev 2, 6/20/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST GENERAL ELECTRIC 34.5 kV AC, TYPE VH-34.5-1500, MODELS: - 0K, -1K, & - 0L VACUUM BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- 35kV AC WESTINGHOUSE LOAD BREAK INTERRUPTER SWITCH TYPE WLI INSTALLED AT C99 TP – 728/1090 DAY INSPECTION, Rev 2, 6/21/13 (for S&I SHOP DC POWER)
    - Data Sheet - WESTINGHOUSE TYPE WLI 34.5KV LOAD INTERRUPTER SWITCHES: C99TP
    - Data Sheet - NO-LOAD INTERRUPTER SWITCH CONTACT RESISTANCE TEST
- SIEMENS 38 kV AC TYPE 38-3AF CPC TYPE SVB3-35 VACUUM BREAKER AND SWITCHGEAR – 728/1090 DAY INSPECTION, Rev 2, 6/20/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST 38 kV AC, SIEMENS TYPE 38-3AF AND CPC TYPE SVB3-35 VACUUM BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- SIEMENS-ALLIS 38 kV AC TYPE V V1500 VACUUM BREAKER AND SWITCHGEAR – 728/1090 DAY INSPECTION, Rev 2, 6/20/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST SIEMENS-ALLIS 38 kV AC, TYPE V V1500 VACUUM BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- ITE (GOULD –ITE) 38 kV AC TYPE 38HKV1500 VACUUM BREAKER AND SWITCHGEAR – 728/1090 DAY INSPECTION, Rev 2, 6/21/13
    - Data Sheet - INSPECTION AND OPERATIONAL TEST ITE (GOULD - ITE) 38 kV AC, TYPE 38HKV1500 VACUUM BREAKER AND SWITCHGEAR
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS
- POWERCON 38 kV AC SWITCHGEAR WITH WESTINGHOUSE 38 kV AC TYPE V VACUUM BREAKER – 1090 DAY INSPECTION, Rev 2, 6/21/13

    - Data Sheet - INSPECTION AND OPERATIONAL TEST POWERCON SWITCHGEAR WITH WESTINGHOUSE 38 kV AC, TYPE V VACUUM BREAKER
    - Data Sheet - MEGGER (INSULATION RESISTANCE) HIPOT (DIELECTRIC WITHSTAND), and CONTACT RESISTANCE TESTS

Non-traction Power Facilities and Systems:

- LIGHTING INSPECTION AND RELAMPING OF WMATA OWNED OR OPERATED FACILITIES, Rev 4, 6/20/13
    - 28-day Exterior Spot Re-lamp
    - 28-day Parking Garage Inspection
    - Quarterly Station Spot Re-lamp
    - Quarterly Spot Re-lamp, all Facilities
    - Quarterly Tunnel Areas Inspection
    - Rail Yards - Quarterly
    - Bus Garages - Quarterly
    - Annual Station Re-lamp
    - Data Sheets:
        - Rail Passenger Station Re-lamping Data Sheet
        - Lighting Inspection Data Sheet - Parking Lots/Bus Loops
        - Lighting Inspection Data Sheet - Facilities
        - Lighting Inspection Data Sheet - Rail Yards
        - Lighting Inspection Data Sheet - Bus Garages
        - Lighting Inspection Data Sheet - Parking Garages
        - Lighting Inspection Data Sheet – Tunnels
- STATIONARY EMERGENCY STAND-BY POWER GENERATOR, Rev 1, 6/17/13
    - Monthly, bi-annual, annual
    - Data Sheets:
        - STATIONARY EMERGENCY STAND-BY POWER GENERATION MAINTENANCE INSPECTION DATA SHEET (2 pages)
        - STATIONARY EMERGENCY STAND-BY POWER GENERATOR OPERATIONAL TEST DATA LOG (2 pages)
- FAN SHAFT POWER SYSTEMS: LIGHTING, AUTOMATIC TRANSFER SWITCHES, VOLTAGE REGULATORS AND MOTOR CONTROL CENTERS - 364 DAY INSPECTION, Rev 2, 6/21/13
    - PMI Data Sheet and Test Record - Fan Shaft Power Systems (2 pages)
- CHILLER PLANT AC DISTRIBUTION SYSTEMS, MOTOR CONTROL CENTERS AND STARTERS – 364 DAY INSPECTION, Rev 2, 6/21/13
    - Data Sheets:
        - INSPECTION AND OPERATIONAL TEST CHILLER PLANTS, PMI DATA SHEET # 1
        - PMI DATA SHEET AND TEST RECORD CHILLER PLANTS MCC, DATA SHEET #2

- PMI DATA SHEET AND TEST RECORD CHILLER PLANTS MCC, DATA SHEET # 3
- PMI DATA SHEET AND TEST RECORD CHILLER PLANTS MCC, DATA SHEET # 4
- PMI DATA SHEET AND TEST RECORD CHILLER PLANTS MCC, DATA SHEET # 5